Developing an Asthma Self-management Intervention Through a Web-Based Design Workshop for People With Limited Health Literacy

Developing an asthma self-management intervention through an online design workshop for people with limited health literacy: process, evaluations, and practical considerations.

Abstract:

Background: Technology, including mobile applications (App), has the potential to support self-management of long-term conditions and can be tailored to enhance adoption. We developed an App to support asthma self-management amongst people with limited health literacy in an online workshop (to ensure physical distancing in a COVID-19 pandemic).

Objective: We aimed to develop and test a prototype asthma self-management mobile application tailored to the needs of people with limited health literacy.

Methods: We recruited participants from a primary care centre in Malaysia. We adapted a Design Sprint methodology to an online workshop in five stages over one-week. Patients with asthma and limited health literacy provided insights into real-life self-management issues in Stage 1, which informed mobile App development in Stages 2 to 4. We recruited additional patients to test the prototype in Stage 5 using a qualitative research design. Participants gave feedback through concurrent thinking-aloud process moderated by a researcher. Each interview took approximately an hour. Screen recordings of App browsing activities were made. Interviews were audio-recorded and analysed using a thematic approach to identify utility and usability issues.

Results: The 'stakeholder discussion identified four themes: individual, family and friends, society and system levels. Five patients tested the prototype. Participants described four ways in which the App influenced or supported self-management (utility); offering information, providing access to an asthma action plan, motivating control asthma through support for medication adherence, and supporting behaviour change through a reward system. Specific usability issues addressed navigation, comprehension, and layout.

Conclusion: It proved possible to adapt the Design Sprint workshop to an online format with the added advantage that it allowed the development and the testing process to be done efficiently through various programmes. The resultant App incorporated advice from stakeholders, including sources for information about asthma, medication and appointment reminders, accessible asthma action plan and sources for social support. The App is now ready to move to feasibility testing.

Keywords: asthma, self-management, design sprint, health literacy

Introduction.

Supported self-management for asthma (written action plans and regular review) is highly effective at improving control and reducing acute attacks [1-3]; however, globally, this is challenging to implement for 334 million people living with asthma [4-7]. One of the challenges is the need to tailor support for people with limited health literacy. Health literacy is defined as the degree to which individuals can obtain, process, and understand the necessary health information needed to make appropriate health decisions [8]. Studies have associated limited health literacy with erroneous health beliefs and poor adherence to self-management activities [9,10]. Malaysia has a high burden of limited health literacy in the general population [11], and asthma control is challenged by lack of patient education, over-reliance on unscheduled visits, and lack of action plan ownership [12-14].

The use of digital technologies is more common in the younger age group as compared to the middle and older age group for internet-based information [15]. ’Malaysia’s multigenerational household culture and strong family orientation have resulted in younger family members assisting older generations in using digital technology to stay connected and find information [16]. The global pandemic has further seen widespread adoption of digital technologies by a broader age group of users in diagnosis, prevention and surveillance [17]. Three-quarters of Malaysians are now smartphones users, including the majority (60.9%) of those in the lowest income group [18]. Despite health-related information-seeking behaviour on the Internet being greater in those with good health literacy [19], our previous qualitative work amongst people with limited health literacy suggests that a mobile App is a preferred medium to deliver supported self-management, including a pictogram-based asthma action plan and signposting to reliable asthma information sources.

Thus, developing asthma self-management tailored to limited health literacy needs is an important context for the online Design Sprint workshop, as various studies have shown that extensive use of pictograms, images, interactive functions and prompts were appealing to participants and may improve understanding of information in mobile Apps [20-23]. However, it is essentialto involve users early in the design stage, as some of the unique features that people want can be time-consuming

and costly to build, and a balance may need to be found between desired features [24] and those with evidence-based recommendations [25,26].

Using a Design Sprint methodology, we sought to optimise user experience in the App development by integrating patients into the 5-stage mapping, sketching, designing, developing and testing process [24,27]. We used the health literacy framework [8] to underpin the interventional work's overall structure. The COVID-19 pandemic and physical distancing requirements meant that we had to conduct our workshop in an online format. We here report the outcomes of the workshop deliberations and our experience of conducting a week-long remote five-stage programme attended by patients with asthma and healthcare professionals.

Methods.

The workshop received ethical approval from the Medical Research and Ethics Committee of the Ministry of Health, Malaysia (ID: NMRR- 19-3609-52292) and sponsorship approval by the Academic and Clinical Central Office for Research & Development (ACCORD) at the University of Edinburgh (ID: AC20011). Informed consent was received from all participants before the workshop.

Study design

We conducted a five-stage design sprint workshop online and qualitative research approach. We used the five-stage Design Sprint process as a roadmap to develop the intervention. We adapted the methodology and constructed the workshop into five-stages: i) understanding and mapping problems; ii) sketching of solutions; iii) deciding on solutions to problems; iv) developing a prototype; v) testing a low-fidelity prototype [27,28]. The process was originally designed in the technology sector by the Google Ventures team for business start-up teams [27]. Involvement of target population and early testing enhance intervention effectiveness and increase the likelihood of adoption at the implementation stage [24]. Due to the rapid development and testing stages, this is an ideal concept for a low resource setting, i.e., time and cost [24].

Stakeholder (patient and healthcare professional) discussions provided insights into self-management issues in Stage 1, which informed mobile App development in Stages 2 to 4. We recruited patients with asthma and limited health literacy to test the

low-fidelity prototype in Stage 5 and give feedback through qualitative interviews. A low-fidelity prototype is a modelled prototype with limited technical functionality [29] that is quick to create and can be easily improved in the light of feedback in the testing stages. The details of each stage are explained in Table 1.

The online workshop discussions were conducted on a web-conference platform, Microsoft Teams (MS Teams) and brain-storming of the idea was conducted on an online board (Miro). While conducting the exercise on the online board, the workshop participants remained connected in the web-conference site to allow ongoing discussion. The online board was superseded by a prototype development (Figma) site in stage 4 and 5, while discussions remained on MS Teams. The App developer supported information technology activities. Two weeks before the workshop, one of the researchers contacted each of the participants (patients and healthcare professionals) to assess technical skills such as the ability to log on, use a meeting platform and logistic issues such as the quality of the internet connection.

Setting

The workshop, which took place between 22nd and 26th June 2020, was conducted through a secured online meeting platform using a virtual whiteboard to facilitate information sharing between the researchers and the App developers. Our original plan for a face-to-face workshop was changed to an online format to overcome the restriction of the order of movement due to the COVID-19 pandemic; additional advantages were that it allowed participants from different locations and time-zones to participate.

The patients were from two urban public primary care clinics in central Malaysia. Asthma is managed in the primary care clinics, which provides chronic and acute care management through the provision of an asthma action plan to support asthma self-management is uncommon. Malaysia has a dual-health system, public and private, where the public health system provides the leading service for the population with co-payment of Ringgit Malaysia, RM1 (USD 0.23) per visit.

Table 1 Process, outcomes and online adaptations of the workshop.

	Stages	Process	The adaptations for online delivery of the workshop.
Stage 1	UNDERSTAND AND MAPPING PROBLEM To identify the objectives of the prototype and the workshop To map out problems from healthcare professionals and patients' perspectives which technology can help to solve.	- As a team, we first discussed and agreed on a long-term goal for the workshop's prototype and aim through a structured discussion between the patients and healthcare professionals. - We listed a list of problems relating to self-managing asthma from stakeholders (patients and clinicians) point of views. - We constructed an end-to-end process of how patients cared for their asthma, and we targeted the problems we could potentially provide solutions for using the mobile App.	- Through a web-conference site (MS Teams), we brain-stormed the long-term goal for the App and the workshop's aim. - In a separate browser, using an online board (Miro), we gathered the problems, potential solutions, and mapping of the target where the solutions can occur. Interviews were audio-recorded during the workshop. - We consider scientific literature and previous study we have conducted as 'expert' input.
Stage 2	SKETCH SOLUTION Objective: To understand a broad range of problems and solutions concerning asthma-self-management	- Focusing on the problems, each researcher reviewed existing ideas which we could potentially use and improve for the prototype. - The individual researcher then presented their findings and the reasons why the ideas being chosen. - Using this information, we then drew crude scenes with our contents which we believed would be suitable for the App. - After presenting the scenes and critical discussions, we voted on the best scene and content for the prototype.	- Reviewing and compiling sketches of ideas were done on Miro synchronously by all researchers. - We presented these sketches of ideas to the whole team on MS Teams. - Individually, using colourful sticky notes and marker pens, we drew the crude scenes. We took photographs of these scenes and uploaded these on Miro. - Each researcher was given three blue dots for the voting, and they placed a dot on the best ideas.
Stage 3	DECIDE ON SOLUTION TO PROBLEM Objective: To decide on solutions that answered our-long term objectives	- The winning scenes and content comprised of topic on asthma education, asthma symptoms monitoring and supporting people living with asthma - We took the winning scenes from our sketches, and we constructed an end-to-end process (storyboard) on how these scenes and content would appear on an App.	- The most voted ideas were put together, and we had another round of voting where each researcher was given a pink dot, and the team leader was given three purple dots on the online board (Miro). - The text and visual version of the storyboard was constructed as a group and through discussions on the online board (Miro) and MS Teams.

		- The storyboard was first constructed in text-form before we transformed it visually.	
Stage 4	PROTOTYPE DEVELOPMENT Objective: To build ideas for a low-fidelity prototype	- Each of the research members and the App developer was assigned roles to ensure the successful development of the low-fidelity prototype for the final day testing process.	- On Figma, a prototype development site, the low-fidelity prototype was developed. - Every researcher and the App developer completed their tasks (i.e., content and language check) within Figma. - Brain-storming of prompts for the testing day was conducted on Google sheet among the researchers. - Google sheet also was where a virtual scoreboard was also set up for every researcher to capture the patient's evaluation of the prototype.
Stage 5	TEST LOW-FIDELITY PROTOTYPE Objective: To validate the solutions for the patients through a qualitative method	- We tested the solutions to five patients using a concurrent think-aloud process. - We gathered verbal and visual feedback about the low-fidelity prototype from the patients, which we will use to build a high-fidelity prototype.	- Interviews were conducted through MS teams by a moderator, HS, with a patient observed by other researchers (whose video and audio function was turned off). - HS and each patient could see each other for an ice-breaking session at the start of the testing session. This session was essential to create rapport and to ensure the patient's readiness, mentally and technically. - The patient was then given a link to the prototype where they could browse through the prototype, gave comments and answered prompted questions. The patient's screen was shared within the MS Team. - The observers synchronously collected the patients' replies on the utility and usability prompts about the prototype during the interview on the virtual scoreboard and the observer's field notes. - The moderator had accessed to the scoreboard and would be able to pick-up any point which needed further clarification. - The interviews were audio-recorded, and browsing activities were video-recorded.

Samples and recruitment.

Stakeholder discussion (Stage 1).

Three patients and two healthcare professionals who cared for asthma in the primary care settings, two App developers, four researchers from Universiti Putra Malaysia and one from the University of Edinburgh were involved in the stakeholder discussion in Stage 1. (see Table 2)

Testing of the prototype (Stage 5).

Five patients, recruited from the Klang Asthma Cohort, participated in testing the prototype in Stage 5 (see Table 2). The Klang Asthma Cohort database is one of the research outputs of RESPIRE (NIHR Global Health research unit on respiratory health) in Malaysia. The database contains 1280 people with asthma who were recruited from primary healthcare clinics in the Klang district. They have given consent to be phoned with invitations to participate in asthma-related research. Inclusion criteria for patients invited for this study were physician-diagnosed asthma, age more than 18, smartphone user, limited health literacy, assessed by screening using *Bahasa Malaysia* language version of the health literacy scale, HLS-Q47 [30]. The initial HLS-Q47 scale [31] was translated and validated in Malaysia with Cronbach α of 0.96 [30].

Table 2 Summary of the stakeholders involved in each stage.

Stakeholder		Stage				
		1	2	3	4	5
1.	Researchers	/	/	/	/	/
2.	Patients	/				/
3.	Healthcare professionals	/				
4.	App developers	/	/	/	/	/

Data collection

We collected demographic information from the database of those patients who agreed to participate. Stakeholders' discussions in stage 1 focused on challenges by patients and healthcare professionals around; i) asthma education, (ii) asthma self-management, (iii) monitoring of symptoms, (iv) emotional support/lifestyle advice, (v) social support, (vi) clinic set-up. (see Appendix 1)

In stage 5, we tested the prototype with five patients to assess its utility and usability using a set of semi-structured questions in a concurrent think-aloud manner

(Appendix 2). During this session, HS, the main interviewer, guided the process. Four other researchers, LPY, SSG, CAT, JW, observed the interview while the two App developers, AG and MM, managed the sessions' technical aspects. The interviews took one hour and were conducted in *Bahasa Malaysia*, the patients' preferred language. *(Hani Salim, HS; Lee Ping Yein, LPY; Sazlina Shariff-Ghazali, SSG; Cheong Ai Theng, CAT; Jasmine Wong, JW; Aidil Goh, AG; Marzuqi Mohamed, MM)*

Qualitative interviews were audio-recorded, other online discussions, browsing activities were video-recorded and online board exercises were captured and archived as described in Table 1. All interviews were transcribed verbatim.

Data analysis

'For this qualitative study, we used thematic analysis to obtain rich data from the stakeholders' discussions in stage 1 and the interviews in stage 5. The texts were analysed iteratively using a deductive thematic analysis approach, as outlined by Braun & Clark (2019) [32]. The deductive thematic analysis seeks to answer the researcher's theory or analytical interest within the topic [32]. Phases in the thematic analysis include [32]: (1) Familiarisation with the data by reading and re-reading and noting down initial ideas (memoing);(2) Duplicate coding (HS and JW) of one interview and comparing decisions to agree on standardised the coding framework before coding all the transcripts;(3) discussing emerging themes with the research team; (4) reviewing themes with the wider research team and generating a map of the analysis (HP/SSG/LPY/CAT/IY); (5) defining themes was achieved iteratively; (6) present the deductive analysis with a selection of extracts. The data were organised using QSR NVivo 11 qualitative data analysis software. *(Hilary Pinnock, HP; Ingrid Young, IY)*

Results

Five patients (including three who attended Stage 1) attended Stage 5 (prototype testing). Table 3 summarises the demographics of patients involved in Stage 5.

Table 3 Patients' demographic involved in Stage 5

ID	Age	Gender	Education level	Health literacy level[†]	Use of pictorial asthma action plan at 6-month	Access to a digital device

P1	44	Female	Secondary	30	Yes	Smartphone and PC
P2	36	Male	Tertiary	32	No	Smartphone
P3	40	Female	Tertiary	17	Yes	Smartphone and PC
P4	38	Male	Tertiary	21	No	Smartphone
P5	19	Male	Secondary	31	No	Smartphone and PC

Footnotes: score less than and equivalent to 33 = limited health literacy[†]

The outcomes of each stage.

Stage 1: Understanding and mapping problems

Three patients and two healthcare professionals (a family physician and a medical officer from Klang District) contributed to the stakeholder's discussion. The stakeholder discussion themes were categorised as relating to individuals, family and friends, society, and systems (Appendix 3). The key problem used to inform the App design was education sources for asthma and support in the community, enabling self-management using pictorial action plan, reminders for medications and asthma reviews/appointments. Log of history of asthma control, preventer intake and information on expected best peak expiratory flow rate (PEFR) were features that could support patients during asthma review/appointment to discuss with their healthcare professionals.

Stage 2-4 Sketching, designing and developing the prototype.

Informed by the stakeholder discussion and findings of our previous qualitative study, we worked through the stages of sketching solutions, designing and developing the prototype (Appendix 4). Through a round of voting in stage 3, solutions supporting self-management based on the evidence-based practice were selected [3]. All the winning solutions were clustered around four aspects of care; 1) education, ii) supporting self-management, iii) supporting behaviour change, iv) social support (see Table 4). We created a storyboard for the prototype, and based on the storyboard; we developed the prototype App, which was then tested on Stage 5.

The whole process is illustrated in Figure 1 and the decisions on prototype content summarised in Table 4. The App was written in the Malay Language.

Table 4 Asthma App content and design features

Main theme	Section	Content	Features
Education	About asthma, its symptoms and diagnosis	Information in text and videos about asthma, symptoms, triggers, how the diagnosis is made, exacerbations and myths around asthma attack. Other information includes types of medications used to treat asthma, its function and potential side-effects of the medications. There will be video-based instructions on the inhaler technique.	The links to the Ministry of Health portal on asthma was provided under specific headings to facilitate the search for reliable information.
	Asthma medications		
Supporting self-management	Self-monitoring of symptoms	Patients indicate any experience of asthma symptoms in the last 24 hour, which will translate into control and prompts to check the action plan	Tick-box list of potential asthma symptoms; ticking any one symptom will prompt a pop-up on advice to look at an action plan with a click button.
	Asthma action plan	A pictorial asthma action plan was used. Illustrations and wordings were validated in a series of discussions with stakeholders.	List of zones are displayed, and patient choose which zone are appropriate for them.
Supporting behaviour change	Asthma medication and appointment reminder	Patients provide information about medications and appointment which will trigger a reminder system at the timing of choice.	Matrix of images of medications used and drop-down menu for frequency and timing.
	Asthma diary	Asthma control and medication uptake will be recorded in the diary, including best PEFR (peak expiratory flow rate).	Monthly calendar, which displays asthma control and adherence.
	Reward system	Achieving good asthma control and medication adherence will be translated into points.	Display of scale of points achieved for good asthma control and adherence.
Others	Social support	Information regarding support groups for asthma in Malaysia.	The links to various support groups available in Malaysia.

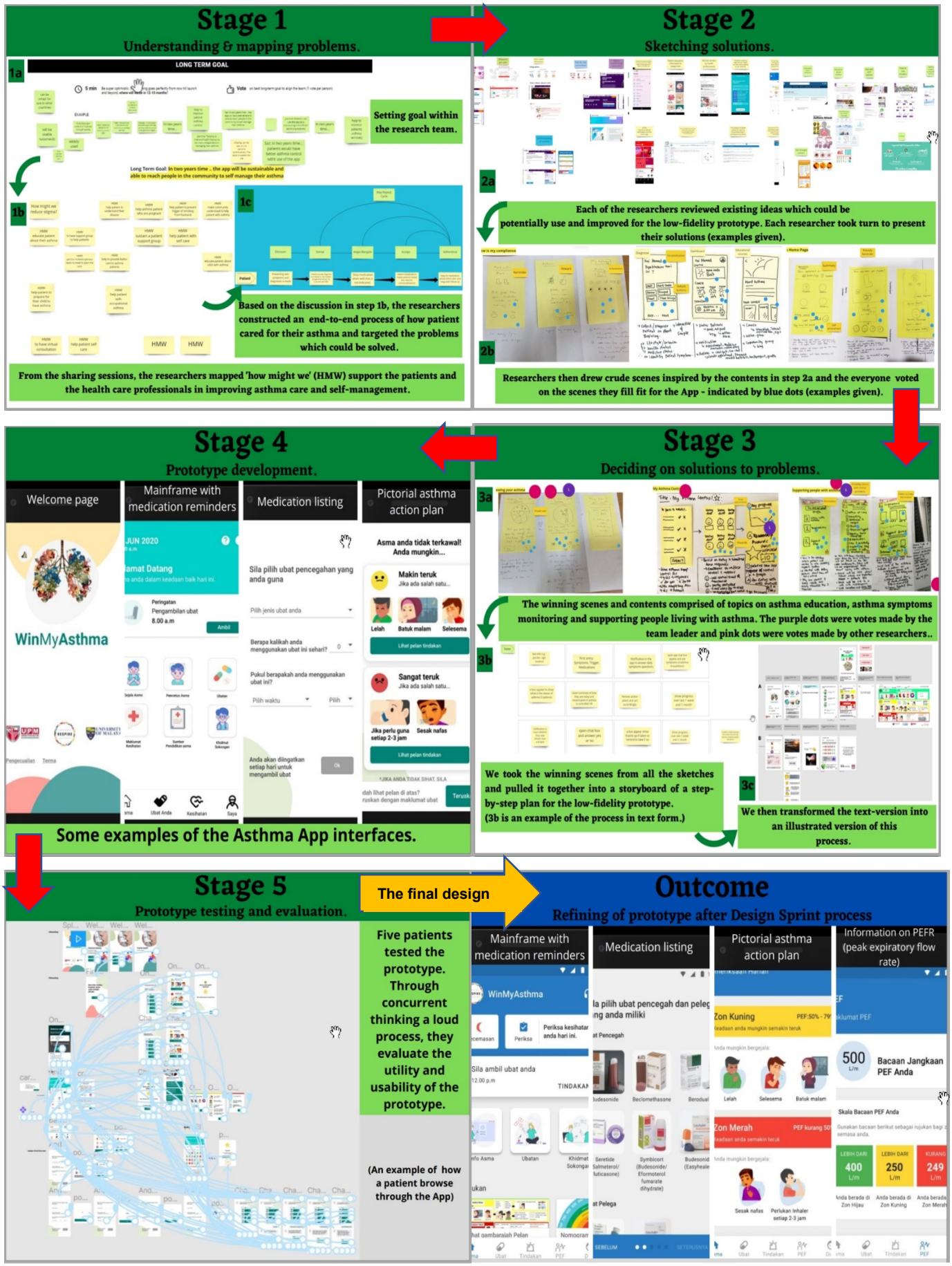

Figure 1 The Design Sprint process undertaken on the online discussion board and meeting platform.

Stage 5 Testing low fidelity prototype

Patients who attended Stage 1 and two other patients attended Stage 5. Results are presented under the two main themes of utility (did the App influence or support self-management) and usability (ease of use).

Utility

Patients commented that the App influenced the decision to self-manage in four ways; offering information, providing an accessible asthma action plan, motivating and supporting improved medication adherence, promoting behaviour change through a reward system.

Offering information

Patients considered that the App provided essential information regarding asthma and how to manage it. P4 explained, '*the information about asthma in the App is interesting and informative'.* Although many were comfortable to read text-based information, some prefer audio-visual format such as video. P5 explained, '*the information about asthma, maybe it can be in the video, it's more interesting than just text.'*

Providing accessible asthma action plans

Patients felt that having the action plan on the phone made the plan accessible when needed. As P1 described, '*when you need the plan, you just open the App in your phone and click on the plan [action], to see it'*. In this format, patients considered it easier to access and use the App-based plan than the paper-based action plan, which they may not carry unless attending medical appointments.

Motivating and supporting improved medication adherence

The medication reminder function of the App was viewed as a good support to achieving good adherence to daily preventer. P5 described, '*It will be difficult not to remember taking the medications because of the reminder, and because I use the phone frequently, it is hard to ignore the reminder (chuckled)'.*

Promoting behaviour change through a reward system

The App was designed to encourage behaviour change through a positive reward system, where good asthma control and adherence to twice daily preventive inhalers would be awarded points, and the cumulative points were visualised clearly. Patients liked this approach. P1 was incredibly excited to see the reward points on the App, '*wow, there is a reward points, this is great!*' This excitement was shared with other patients who preferred to see tangible results of their actions. P3 elaborated on how the reward system could influence behaviour, '*That's nice when I get points for taking the medications. I do want to see that I accumulate points and the scale moved further. And I can only do this if my control is good and if I take my medications*'

Usability

The patients could easily comprehend information and instructions in the App. P2 elaborated on how he achieved this, '*the instructions are accompanied with illustrations. It makes it easier to understand it'.* Although patients liked the use of illustrations and fewer words, the small font size used was challenging for some. P1 said. '*the writing is small. I tried to put on my glasses, I still can't see it (chuckled)'*. We used cartoon-based illustrations of the medications and in the steps of the asthma action plan. Some suggested that the pictorial asthma action plan may be useful for patients with asthma other than adults. P3 suggested, *'I think the illustrated plan can be appealing and useful for children and their carer. It's very easy to understand.'*

Patients pointed out that a lack of navigational symbols meant that it was not always clear how to move from one interface to another. P4 stated his confusion, '*There is no sign or indication on what to do next. I was a bit lost on what should I do now. Perhaps an arrow would help to tell that I can move forward'.* Otherwise, patients were mostly satisfied with the simple layout. P1 gave an example of this, '*In terms of the layout, it's quite easy to navigate around the App. It's ok for me.'*

The time spent in using the App varied (10 – 45 minutes). Some (younger) patients seemed comfortable navigating from one interface to the other and were keen to click buttons to explore the App functions. In contrast, others were dependent on symbols or prompt to navigate, which the App lacked at the testing stage.

The language used in the App was generally satisfactory, although there was a linguistic misunderstanding of 'breathlessness' and 'wheeze' in the *Bahasa Malaysia*

language. P4 described his confusion on the *Bahasa Malaysia* words for breathlessness and wheeze, '*Mengalami sesak nafas (breathlessness) and lelah (wheezing), are different? I thought it's the same thing?'*

After the workshop.

The design was refined and finalised after the testing in stage 5 (Figure 2)

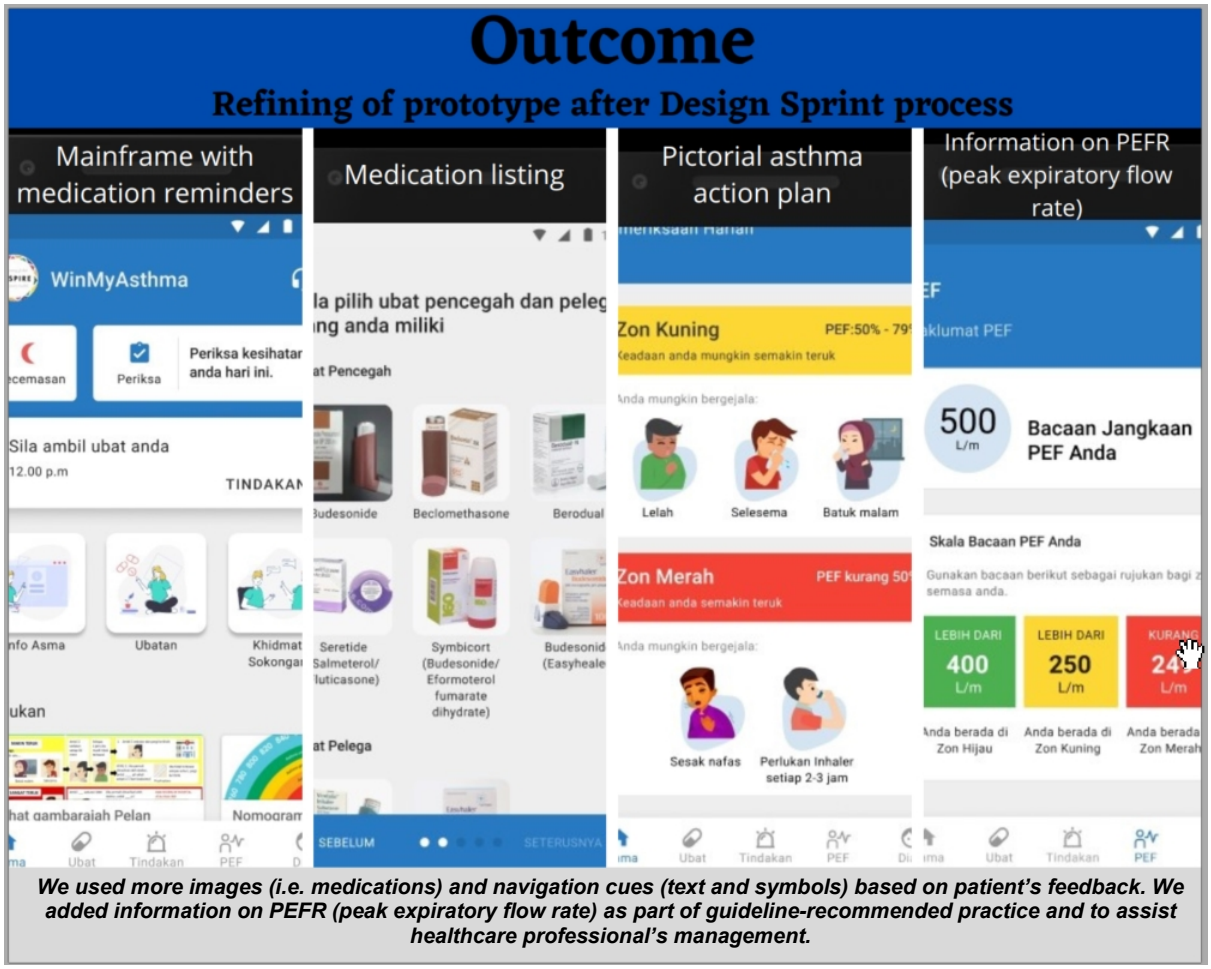

Figure 2 The finalised App design.

Discussion.

Summary of findings.

We conducted a design sprint workshop and employed an online format to ensure the researchers and the patients' safety during the global pandemic. In this five-stage workshop, we developed a 'low-fidelity prototype based on theoretical frameworks and refined it based on patient feedback during the design and testing stages. Patients described the resultant App to influence their ability to self-manage in four ways; offering information, providing accessible asthma action plans, motivating and supporting improved medication adherence, promoting behaviour change through

a reward system. Specific usability issues were related to navigation, comprehension, and layout.

Strengths and limitations.

The involvement of stakeholders and the multidisciplinary approach at the development stage in the Design Sprint process are among the strengths of this study, which may increase the chances of the intervention meeting the needs of the target population. The five-stage Design Sprint structure allowed the development and testing process to be done quickly and efficiently at a low cost, which would likely be favourable in low resource settings. Constructing a low-fidelity prototype offered many advantages in the initial stage of prototype development. It allowed a quick gathering of requirements, ideas, concepts and could be built rapidly [29]. The disadvantage was that the low-fidelity prototype lacked some core functionality (such as navigation features), so that the patients on day five were giving feedback on a limited version of the App. Nevertheless, the feedback was beneficial and enabled the App to be refined after the workshop to produce a high-fidelity prototype.

The online approach connected people in different geographical locations and ensured safety during the global pandemic. We recognised that we do not have any participants over the age of 50 years, maybe because this approach may be more appealing to younger age groups, although with limited health literacy and may not reflect the feasibility of using online methods for older age groups. We overcame limited internet access by providing an internet data voucher, but we had to exclude those with no access to any digital devices. We provided training on the various platforms to be used in the workshop, thus overcoming the lack of digital skills. These strategies may assure researchers/intervention developers working in countries/settings with high levels of limited health literacy that this online methodology is of value.

The pandemic context may have explained the relatively small number of participants we could recruit during the testing stage. Some participants found it challenging to commit uninterrupted time to an online workshop while ‘locked down’ at home with their domestic/caring/’home-schooling’ responsibilities. For comparison, face-to-face intervention design workshops have been reported with 14 participants at 5-day workshops [33] and 38 participants over six weeks [34].

Adaptation of the Design-Sprint Workshop to an online format.

Patients with asthma and healthcare professionals had been recruited for a workshop in March 2020, but this could not occur due to the compulsory lockdown imposed by the local authority in response to the COVID-19 pandemic. We, therefore, adapted the workshop to the challenges of an online format and the potential impact on participants' research experience [35]. A high-speed internet connection and technical skills in conducting this workshop were vital. To overcome some of these practical issues, we supported all participants with mobile online access through a RM 10 (USD 2.42) internet data voucher to ensure the participants would not bear the cost of internet access. Participants' experience with technologies were around social media, i.e., Facebook, video-call, i.e., WhatsApp, information searching platforms, i.e., Google and YouTube. We found a lack of experience with video-conferencing platforms and the software we planned to use during the testing day. Thus, we conducted training sessions for all participants to avoid technical problems during the workshop.

In the context of interviews, the literature suggests that online data collection can produce data of a similar quality to face-to-face interviews [35]. Although using an online platform to interview patients was a new experience for the researchers, we found that the online programmes eased discussion, and interviews took place quickly and effectively. Compared to traditional qualitative interviews, one advantage was that other researchers could observe the interview sessions in the online platform, and they could make concurrent fieldnotes. From the patient's feedback, although they knew they were being observed by additional researchers, being at their own home helped them to forget about being observed and being anxious.

In online discussions and interviews, dictation software has been used to capture the audio data in text format, reportedly avoiding transcription errors [36,37]. However, this was not possible in our context because the medium of interaction was the *Bahasa Malaysia* language*,* and the extensive use of colloquial language made it impossible to use any dictation software. Conducting research online raises concerns about participants confidentiality and data security. We ensured that entry to the workshop was password-protected to control access to maintain the participant's

confidentiality securely. Recordings were stored securely. For example, files from the workshop were encrypted and stored in a secure research data storage facility.

We outlined recommendations for practice, policy and research based on this study in Table 5. On a practical level, to help researchers' concentration throughout the five 9-hour days of the workshop, we included frequent breaks and provided high-energy snacks. Each session was either one hour long, with fifteen minutes break or forty-five minutes long, with ten minutes breaks. Committing to time in a workshop alone in front of the monitor can be challenging and mentally draining, so a week before the workshop, each researcher received a supply of high energy snacks through the post. We also provided coloured sticky notepad and permanent markers with similar tip size to ensure all scanned sketches and writings were clear when uploaded on the online discussion board.

Table 5 Recommendations for practice, policy and research.

Practice	• Although some participants only join the workshop for short periods, researchers and technical colleagues have to concentrate online for long periods. Adequate breaks, attention to nutrition, and general comfort are important. • The online platforms may be unfamiliar to many participants; training prior to the workshop gives confidence and helps reduce technical problems on the day. • Due to the relatively low cost and a short time spent from development to testing, the online design sprint methodology may be suitable for low resource settings. • Remote conduct ensured that high-risk stakeholders were shielded during a pandemic and overcame geographical barriers
Policy	• The process is ‘a sprint’ so that the end-product can be developed to a short timescale to meet pressing deadlines.
Research	• The feasibility study of conducting a more extensive scale online intervention design program is necessary to ensure its practicality. • Our technical colleagues were innovative, but the development of a user-friendly system that can support an agile intervention framework is needed.

Online design workshop, the context of limited health literacy in an LMIC.

Our App focused on designing a pictorial asthma action plan as a core strand of tailoring supported self-management to people with limited health literacy. Other features were a simple language for symptom assessment, education and

information resources, provision of visual and audio medication reminders, and practical behaviour change strategies such as a reward system. A clear message from our previous qualitative work was that participants wanted an interactive approach to supporting an asthma action plan with few words and clear pictures. Our original plan had been to provide a paper-based pictorial action plan, but that is not interactive, so we reconsidered potential formats and decided to deliver the pictorial asthma action plan using a mobile application. Using a mobile App was seen as promoting a sense of autonomy to feel empowered in managing their asthma.

Although previous reviews have reported a lack of interest in action plans [21], others have reported on the keenness of people to use action plans in mobile Apps [38], though none have explored plans tailored for people with limited health literacy or the innovative pictorial representation of actions in a mobile App. In the United States, a study found that action plans were written at the literacy level of sixth-grade (11 to 12-year-old), which will be a challenge to those without formal education or only receiving primary school education [39]. The same study also found that more graphics within an action plan may be needed to increase ease of use [39]. In our online design workshop, the extensive use of images, icons and the use of simple language were among the strategies used to overcome the challenge in understanding a written asthma action plan.

Conclusion.

Working with people with limited health literacy enabled the development of an App that could support them to self-manage their asthma. Specific components included sources of information on asthma, pictorial asthma action plan, simple language, audio-visual prompts and rewards to support adherence to daily therapy and scheduled reviews. Despite practical challenges, a five-day online Design Workshop proved to be manageable enabling meaningful engagement from patients and HCPs so that a prototype is now ready for feasibility testing.

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Authors' contributions: HS, HP, LPY, SSG and IY involved in the formulating the ideas for the study. HS and JW did planning and conducted training for participants. HS,

LPY, SSG, CAT, JW conducted the workshop and performed the data collection. HS conducted data analysis and all authors involved in data interpretations. HS drafted the manuscript. All authors critically revised the manuscript for its intellectual content. All authors read and approved the final manuscript.

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Conflict of interest:

All the authors had no competing interest in the conduct of this study.

Abbreviations:

MRC - Medical Research Council
ACCORD - Academic and Clinical Central Office for Research & Development
RM - Ringgit Malaysia
RESPIRE – NIHR Global Health research unit on respiratory health
NIHR – National Institute for Health Research
HLS - health literacy scale
MS Teams – Microsoft teams
PEFR - peak expiratory flow rate

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